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(54) **METHOD OF RAPID CONVERSION OF CHEMICAL ENERGY INTO USABLE ELECTRICAL ENERGY**

VERFAHREN ZUR SCHNELLEN UMWANDLUNG VON CHEMISCHER ENERGIE IN NUTZBARE ELEKTRISCHE ENERGIE

PROCÉDÉ DE CONVERSION RAPIDE D'ÉNERGIE CHIMIQUE EN ÉNERGIE ÉLECTRIQUE UTILISABLE

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Description

BACKGROUND

1. Field

[0001] The present disclosure relates to methods and system of converting chemical or kinetic energy into usable electrical energy.

2. Description of the Related Art

[0002] Charging appliances while in remote field locations can be challenging. Existing solutions generally involve carrying multiple charged replacement batteries. However, batteries are heavy, have relatively low energy density, and slowly lose energy, thereby requiring frequent recharging which may not always be possible. What is needed is a more convenient, lightweight, and higher energy density method of storing energy while in the field. Embodiments described herein satisfy this need.

[0003] Document US 2009/108589 A1, in accordance with its abstract, states a firearm improvement taking the form of a mechanical dynamo installed in an automatic firearm. Several components either replace certain parts of the firearm or are added to the firearm. In conjunction with the operation of the firearm, the components generate electric energy which is then stored in a capacitor, battery, or other element for the storage of electric energy, or supply power to a battery recharging unit attached to the firearm. The electric energy contained in the storage component, or used to recharge the batteries placed in the recharging unit, may be used at a later time as a back-up power supply for electronic components attached to or incorporated into the firearm, such as red-dot or reflex sights, laser sighting equipment, or night vision equipment.

SUMMARY

[0004] The present disclosure describes a regenerative braking system for converting kinetic energy of a projectile into electrical energy suitable for powering appliances or charging a battery.

[0005] The present disclosure further describes a method of operating a firearm, comprising:

firing a firearm so as to propel a projectile from the firearm;
converting a kinetic energy of the projectile into an electrical energy; and
charging a battery using the electrical energy.

[0006] In one or more examples, the method further comprises providing the firearm comprising a barrel including a bore; providing a circuit including a plurality of electrically conductive components distributed along a length of the bore; and providing the projectile comprising at least one of a conductive material or a magnetic material magnetically coupled to the electrically conductive components when the projectile is moving along the length of the bore. The circuit stores energy generated from an electric current induced in the electrically conductive components when the projectile moving along the length of the bore causes a magnetic interaction between the electrically conductive components and the at least one of the magnetic material or the conductive material. The magnetic interaction causes braking of the projectile. Currently claimed invention relates to a system as defined in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Fig. 1 illustrates a regenerative braking system according to a first example.
Fig. 2 illustrates a regenerative braking system according to a second example.
Fig. 3 illustrates an example magnetic field distribution in a regenerative braking system according to one or more examples described herein.
Fig. 4 illustrates a soldier or hiker using a regenerative braking system in a field application, according to one or more examples described herein.
Fig. 5 illustrates a vehicle including a regenerative braking system according to one or more examples described herein.
Fig. 6 is a flowchart illustrating a method of making a regenerative braking system according to one or more examples described herein.

Fig. 7 is a flowchart illustrating a method of using a regenerative braking system, according to one or more examples described herein.

DESCRIPTION

[0008] In the following description, reference is made to the accompanying drawings which form a part hereof, and which show, by way of illustration, several examples. It is understood that other examples may be utilized and structural changes may be made without departing from the scope of the present disclosure.

Technical Description

[0009] The present disclosure describes a system that uses Faraday's law to rapidly and directly convert kinetic energy of a magnetized and/or conductive projectile (propelled by chemical energy) into usable electrical energy. In one example, the magnetic braking effect of an "inverse coil gun" removes energy from a high kinetic energy projectile (whose initial kinetic energy is generated from chemical energy) and produces a voltage in a circuit magnetically coupled to projectile. The electrical energy associated with the voltage is used directly by an application or to charge capacitors or batteries for later use. This system drastically reduces the weight of energy storage.

Firearm Example

[0010] Fig. 1 illustrates a regenerative braking system 100 comprising a barrel 102 including a bore 104; a circuit 106 including a plurality of electrically conductive components 108 distributed along a length 110 of the bore 104; and a projectile 112 comprising a material 114 selected from at least one of a conductive material or a magnetic material magnetically coupled to the electrically conductive components 108 when the projectile 112 is moving along the length 110 of the bore 104. Example electrically conductive components 108 include, but are not limited to, coils 144 or pick up coils 144b coupled to a magnet 147. Example magnetic materials include, but are not limited to, a permanent magnet 145.

[0011] The circuit 106 stores energy 116 generated from an electric current 118 induced in the electrically conductive components 108 when the projectile 112 moving along the length 110 of the bore 104 causes a magnetic interaction 120 between the electrically conductive components 108 and the material 114. The magnetic interaction 120 also causes braking or slowing of the projectile 112. In one or more examples, the circuit 106 comprises (or is connected to) capacitors 154 and/or batteries 156 used to store the energy 116 for powering an appliance or other device 158. Preferably, according to one aspect, the electrically conductive components 108 are connected in parallel with the capacitors 154.

[0012] In the example illustrated in Fig. 1, the system is an attachment that can be removably attached to, or retrofitted on, a firearm 130. A connector 132 is used to attach the barrel 102 to the muzzle 134 of the firearm 130 so that the projectile 112 (a bullet 136) is fired into the barrel 102 from the muzzle 134. The barrel 102 or the connector 132 comprises a vent 138 positioned forward of the electrically conductive components 108, so that the vent 138 vents an exhaust 140 from the firearm 130.

Piston Example

[0013] Fig. 2 illustrates an example regenerative braking system 200 wherein the projectile 112 comprises a piston 202. The system further includes a reactor 204 (e.g., combustion chamber 203) coupled to the barrel 102 and the reactor 204 is configured to (1) react a chemical propellant 206 with a reactant 208 (e.g., air or oxygen) so as to form an exhaust product 210, and (2) direct the exhaust product 210 to propel the piston 202 through the bore 104. The reactor 204 comprises an intake 212 for inputting air, an exhaust 214 for outputting exhaust product 210, and a spark plug 216 for igniting the chemical propellant 206. The regenerative braking system 200 further comprises a mechanism 218 for returning the piston 202 to the reactor 204 after the piston 202 has traveled the length 110 of the bore 104 following propulsion and braking. In the illustrated example, the mechanism 218 comprises a connecting rod 220, a crank 222, a crank pin 224, and a crank shaft 226, wherein a portion of the reciprocating motion of the piston 202 is converted to rotational motion of the crank 222 which is then used to push the connecting rod 220 that drives the piston back to the reactor 204.

Example Magnetic Field Distributions

[0014] Fig. 3 illustrates various example magnetic interactions 120 between the electrically conductive components 108 and the projectile 112 which is magnetized. In one implementation, the projectile 112 generates a first magnetic field 122 configured to induce the electric current 118 in the electrically conductive components 108 when the projectile

112 is moving along the length 110 of the bore 104. The electric current 118 generates a second magnetic field 124 and the electrically conductive components 108 are configured so that the magnetic interaction 120 of the second magnetic field 124 with the first magnetic field 122 causes the braking of the projectile 112, e.g., as the kinetic energy 117 of the projectile 112 is converted to electrical energy 116. In various examples, the second magnetic field 124 does not extend behind the projectile 112 so as to prevent pushing of the projectile 112 along the bore 104.

[0015] In another implementation wherein the projectile 112 comprises a conductive material, the magnetic interaction 120 induces an eddy current in the conductive material in the projectile 112 moving along the length 110 of the bore 104. The formation of the eddy current causes the braking of the projectile as kinetic energy 117 of the projectile is dissipated in the eddy current.

Application Examples

[0016] Fig. 4 illustrates a human 400 (e.g., a soldier 402 or a hiker 404) operating the regenerative braking system 100 comprising a hand held or portable device. The hand held device is used to charge a battery for small scale power generation out in the field. In one or more examples, the electrically conductive components 108 are configured so that the braking causes the projectile 112 to exit the bore at a speed of less than 10 m/s, at a speed that can be stopped by an unprotected hand or a protected hand (e.g., a hand protected with armor or a glove). In one or more further examples, the projectile has a kinetic energy reduced by at least 90%-99% and at least a portion of the kinetic energy is converted to the energy 116 comprising electrical energy. The average energy in a moving 50 caliber rifle cartridge is approximately 50 kJ, which is more than sufficient to charge an alkaline AA battery (~10 kJ energy storage capacity), a C battery (~35 kJ energy storage capacity), a NiCad battery (~1/3 of these energies) or a NiMH battery (~1/2 of these energies). Multiple firings or larger caliber cartridges can be used to charge an alkaline D-battery (~75 kJ energy storage capacity).

[0017] In one or more examples, the energy 116 is capable of powering at least one appliance or device 158 selected from a cell phone, a radio, a television, a computer, a global positioning system, an air conditioning system, or an electric vehicle motor (electric motor).

[0018] Fig. 5 illustrates a vehicle 500 (a tank) comprising the regenerative braking system 200 illustrated in Fig. 2. The vehicle further comprises an electromagnetic weapon 502 and the regenerative braking system 200 is used for rapid charging of the energy system for the electromagnetic weapon 502. Although a tank is illustrated, in other examples the regenerative braking system 200 is mounted on an aircraft or watercraft (e.g., boat) near a naval or aircraft gun for rapid charging of the naval gun or the aircraft gun, respectively. A fired M1 Abrams tank shell has an energy of ~30 MJ which is sufficient to charge multiple batteries or a hybrid car battery (~5.4 MJ storage capacity). Other example vehicles include, but are not limited to, a car, a truck, a jeep, or a bus.

Table 1: Various energy capacities for standard batteries and kinetic energies of various caliber bullets that could be used to charge these batteries, wherein bullets are referred in with their NATO nomenclature.

battery	energy (J)	weight (g)	J/g	Rechargeable
AA Alkaline	9360	24	390.0	No
AA Li-Ion	11050	24	460.4	No
AA NiCd	4320	29	149.0	Yes
AA NiMH	9072	26	348.9	Yes
D Alkaline	74970	135	555.3	No
D NiCd	21600	200	108.0	Yes
D NiMH	41040	170	241.4	Yes
bullet	energy (J)	weight (g)	J/g	
5.56x45	1796	11.9	150.9	
7.62x51	3304	25.5	129.6	
7.62x39	2108	18.2	115.8	
9x19	570	8	71.3	
.50 BMG	18100	120	150.8	

Process Steps

Method of manufacturing

[0019] Fig. 6 illustrates a method of making a regenerative braking system (referring also to Fig. 1 and Fig. 2).

[0020] Block 600 represents obtaining or manufacturing a barrel 102 comprising a bore 104. In one or more examples, the barrel and bore are manufactured using materials typically used for the manufacturing of firearms (e.g., metal). Example barrels and bores include, but are not limited to, bores and barrels having a cylindrical cross-section or a non-cylindrical cross-section.

[0021] Block 602 represents disposing or distributing a plurality of electrically conductive components 108 along a length 110 of the bore 104. Example electrically conductive components include, but are not limited to, coils 144 (comprising wire), windings (comprising wire), or pick up coils (comprising wire) coupled to a magnet. In one example, the electrically conductive components comprise a linear set of coils disposed linearly along the length of the bore. Example materials for the electrically conductive components include materials typically used for the manufacture of conductive coils and windings, e.g., wires comprising metal (e.g., silver, copper, tungsten, etc.). Example materials for the magnet include, but are not limited to, rare earth materials (e.g., neodymium).

[0022] Block 604 represents obtaining or manufacturing a projectile 112 comprising at least one material 114 selected from a conductive material or a magnetic material that can be magnetically coupled to the electrically conductive components when the projectile is moving along the length of the bore. Example magnetic materials include a permanent magnet comprising, for example rare earth materials (e.g., neodymium). Example materials for the conductive material include materials typically used for the manufacture of conductive coils, windings, loops, or wires, e.g., metal such as, but not limited to, silver, copper, tungsten, etc.

[0023] Block 606 represents connecting a circuit including the electrically conductive components. The circuit 106 is configured to store energy 116 generated from an electric current 118 induced in the electrically conductive components when the projectile moving along the length of the bore causes a magnetic interaction 120 between the electrically conductive components and the material. In one or more examples, the circuit 106 comprises (or is connected to) capacitors 154 and/or batteries 156 used to store the energy 116.

[0024] In one or more examples, the circuit 106 comprises a buffer circuit, for :

- charging capacitors 154 using the electrical current 118 and with a first time constant commensurate with a timescale of the projectile 112 traveling along the bore 104, and
- discharging the capacitors 154 into the battery 156 with a second time constant longer that the first time constant and commensurate with a charging time in accordance with the battery manufacturer's specifications.

[0025] Block 608 represents the end result, a regenerative braking system as illustrated in Fig. 1 or Fig. 2.

[0026] Block 610 represents attaching the regenerative braking system to a firearm, reactor, or other system for propelling the projectile along the bore. Examples of firearm include, but are not limited to, a gun, pistol, assault weapon, or machine gun. Examples of reactor include, but are not limited to, a combustion chamber as used in a combustion engine.

Method of Operation

[0027] Fig. 7 illustrates a method of operating a firearm.

[0028] Block 700 represents firing a firearm so as to propel a projectile from the firearm.

[0029] Block 702 a represents converting a kinetic energy of the projectile into an electrical energy.

[0030] Block 704 represents charging a battery using the electrical energy.

[0031] This method solves the problem of charging weaponry or other devices in the field. Specifically, the method is able to rapidly convert high-density chemical energy into usable electrical energy using direct energy conversion, reducing weight of energy storage compared to state-of-the-art batteries..

[0032] Existing solutions generally involve carrying multiple charged replacement batteries. However, batteries are heavy with relatively low energy density compared to chemical energy solutions. Moreover, batteries slowly lose energy and need frequent recharging, which requires a recharging power supply and energy source. Embodiments of the methods described herein require that only one battery is transported in the field since the energy is stored in the chemical energy of the propellant used to fire the projectile and the chemical energy is only converted to electrical energy when needed to recharge the battery.

Conclusion

[0033] This concludes the description of the examples of the present disclosure. The foregoing description of the examples has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of rights be limited not by this detailed description, but rather by the claims appended hereto.

Claims

1. A regenerative braking system (100), comprising:

   a barrel (102) comprising a bore (104);
   a circuit (106) including a plurality of electrically conductive components (108) distributed along a length (110) of the bore (104);
   a projectile (112) comprising at least one of a conductive material (114) or a magnetic material (114) magnetically coupled to the electrically conductive components (108) when the projectile (112) is moving along the length (110) of the bore (104); and wherein:

      the circuit (106) is configured to store energy (116) generated from an electric current (118) induced in the electrically conductive components (108) when the projectile (112) moving along the length (110) of the bore (104) causes a magnetic interaction (120) between the electrically conductive components (108) and the at least one of the magnetic material (114) or the conductive material (114), and
      the magnetic interaction (120) is configured to cause braking of the projectile (112),
      characterized in that the regenerative braking system (100) further comprises a connector (132) configured to attach the barrel (102) to a muzzle (134) of a firearm (130), wherein the projectile (112) comprises a bullet (136) configured to be fired into the barrel (102) from the muzzle (134), wherein: the barrel (102) comprises a vent (138) positioned forward of the electrically conductive components (108), and
      wherein the vent (138) is configured to vent an exhaust (140) from the firearm (130).

2. The system of claim 1, wherein:

   the projectile (112) is configured to generate a first magnetic field (122) configured to induce the electric current (118) in the electrically conductive components (108) when the projectile (112) is moving along the length (110) of the bore (104), and
   the electric current (118) is configured to generate a second magnetic field (124) and the electrically conductive components (108) are configured so that the magnetic interaction (120) of the second magnetic field (124) with the first magnetic field (122) causes the braking of the projectile (112).

3. The system of claims 1 or 2, wherein the magnetic interaction (120) is configured to induce an eddy current in the conductive material (114) in the projectile (112) moving along the length (110) of the bore (104).

4. The system of claim 1, wherein the electrically conductive components (108) are configured so that:

   the projectile (112) exits the bore (104) at a speed that can be stopped by hand, or the speed is less than 10 m/s, or the projectile (112) has a kinetic energy (117) reduced by at least 90% and at least a portion of the kinetic energy (117) is converted to energy (116) comprising electrical energy (116).

5. The system of any one of claims 1-4, wherein the magnetic material (114) comprises a permanent magnet (145).

6. The system of any one of claims 1-5, wherein the electrically conductive components (108) comprise coils (144).

7. The system of any one of claims 1-6, wherein the circuit (106) comprises one or more capacitors (154) configured to store the energy (116) generated from the electrical current (118).

8. The system of claim 7, wherein the electrically conductive components (108) are connected in parallel with the capacitors (154).

9. The system of any one of claims 1-8, further comprising:
   a battery (156) connected to the circuit (106), wherein the battery (156) is configured to store the energy (116).

10. The system of claim 9, wherein the energy (116) is capable of powering at least one device (158) selected from a cell phone, a radio, a television, a computer, a global positioning system, an air conditioning system, or an electric vehicle motor.

11. The system of claims 9 or 10, wherein the circuit (106) comprises a buffer circuit for:

charging capacitors (154) using the electrical current (118) and with a first time constant commensurate with a timescale of the projectile (112) traveling along the bore (104), and
discharging the capacitors (154) into the battery (156) with a second time constant longer that the first time constant and commensurate with a charging time in accordance with manufacturer specifications for the battery (156).

12. A vehicle (500) comprising an electromagnetic weapon (502) powered using the system of any one of claims 1-11.

Patentansprüche

1. Regeneratives Bremssystem (100), das aufweist:
einen Lauf (102) mit einer Bohrung (104);

eine Schaltung (106) einschließlich einer Vielzahl von elektrisch leitenden Komponenten (108), die entlang einer Länge (110) der Bohrung (104) verteilt sind;
ein Projektil (112), das zumindest ein leitendes Material (114) oder ein magnetisches Material (114) aufweist, das magnetisch an die elektrisch leitenden Komponenten (108) gekoppelt ist, wenn sich das Projektil (112) entlang der Länge (110) der Bohrung (104) bewegt; und wobei:

die Schaltung (106) eingerichtet ist, Energie (116) zu speichern, die aus einem elektrischen Strom (118) erzeugt wird, der in den elektrisch leitenden Komponenten (108) induziert wird, wenn das Projektil (112), das sich entlang der Länge (110) der Bohrung (104) bewegt, eine magnetische Wechselwirkung (120) zwischen den elektrisch leitenden Komponenten (108) und dem magnetischen Material (114) und/oder dem leitenden Material (114) hervorruft, und
die magnetische Wechselwirkung (120) eingerichtet ist, ein Bremsen des Projektils (112) hervorzurufen, **dadurch gekennzeichnet, dass** das regenerative Bremssystem (100) ferner eine Verbindungseinrichtung (132) aufweist, die eingerichtet ist, den Lauf (102) an einer Mündung (134) einer Feuerwaffe (130) anzubringen, wobei das Projektil (112) ein Geschoss (136) aufweist, das eingerichtet ist, in den Lauf (102) aus der Mündung (134) gefeuert zu werden, wobei: der Lauf (102) eine Entlüftung (138) aufweist, die vor den elektrisch leitenden Komponenten (108) positioniert ist, und
wobei die Entlüftung (138) eingerichtet ist, Abgas (140) aus der Feuerwaffe (130) zu entlüften.

2. System nach Anspruch 1; wobei:

das Projektil (112) eingerichtet ist, ein erstes magnetisches Feld (122) zu erzeugen, das eingerichtet ist, den elektrischen Strom (118) in den elektrisch leitenden Komponenten (108) zu induzieren, wenn sich das Projektil (112) entlang der Länge (110) der Bohrung (104) bewegt, und
der elektrische Strom (118) eingerichtet ist, ein zweites magnetisches Feld (124) zu erzeugen, und die elektrisch leitenden Komponenten (108) so eingerichtet sind, dass die magnetische Wechselwirkung (120) des zweiten magnetischen Felds (124) mit dem ersten magnetischen Feld (122) die Bremsung des Projektils (112) verursacht.

3. System nach Anspruch 1 oder 2, wobei die magnetische Wechselwirkung (120) eingerichtet ist, einen Wirbelstrom in dem leitenden Material (114) in dem Projektil (112) zu induzieren, das sich entlang der Länge (110) der Bohrung (104) bewegt.

4. System nach Anspruch 1, wobei die elektrisch leitenden Komponenten (108) derart eingerichtet sind, dass:

das Projektil (112) die Bohrung (104) mit einer Geschwindigkeit verlässt, die von Hand gestoppt werden kann, oder die Geschwindigkeit weniger als 10 m/s beträgt, oder
das Projektil (112) eine kinetische Energie (117) aufweist, die um mindestens 90% verringert ist, und zumindest

ein Teil der kinetischen Energie (117) in eine Energie (116) gewandelt ist, die elektrische Energie (116) aufweist.

5. System nach einem der Ansprüche 1-4, wobei das magnetische Material (114) einen Permanentmagneten (145) aufweist.

6. System nach einem der Ansprüche 1-5, wobei die elektrisch leitenden Komponenten (108) Spulen (144) aufweisen.

7. System nach einem der Ansprüche 1-6, wobei die Schaltung (106) einen oder mehrere Kondensatoren (154) aufweist, der bzw. die eingerichtet sind, die aus dem elektrischen Strom (118) erzeugte Energie (116) zu speichern.

8. System nach Anspruch 7, wobei die elektrisch leitenden Komponenten (108) mit den Kondensatoren (154) parallel verbunden sind.

9. System nach einem der Ansprüche 1-8, das ferner aufweist:
eine Batterie (156), die mit der Schaltung (106) verbunden ist, wobei die Batterie (156) zum Speichern der Energie (116) eingerichtet ist.

10. System nach Anspruch 9, wobei die Energie (116) zumindest eine Vorrichtung (158) mit Energie versorgen kann, die ausgewählt ist aus einem Handy, einem Radio, einem Fernseher, einem Computer, einem globalen Positionierungssystem, einer Klimaanlage oder einem elektrischen Fahrzeugmotor.

11. System nach Anspruch 9 oder 10, wobei die Schaltung (106) eine Pufferschaltung aufweist zum:

    Laden von Kondensatoren (154) unter Verwendung des elektrischen Stroms (118) und einer ersten Zeitkonstanten, die einer Zeitskala entspricht, mit der sich das Projektil (112) entlang der Bohrung (104) bewegt, und Entladen der Kondensatoren (154) in die Batterie (156) mit einer zweiten Zeitkonstanten, die länger als die Zeitkonstante ist und die einer Ladezeit in Übereinstimmung mit Herstellerspezifikationen für die Batterie (156) entspricht.

12. Fahrzeug (500), das eine elektromagnetische Waffe (502) aufweist, die unter Verwendung des Systems nach einem der Ansprüche 1-11 mit Energie versorgt wird.

Revendications

1. Système de freinage régénératif (100), comprenant:

    un canon (102) comprenant un alésage (104);
    un circuit (106) incluant une pluralité de composants électriquement conducteurs (108) répartis le long d'une longueur (110) de l'alésage (104);
    un projectile (112) comprenant au moins l'un d'un matériau conducteur (114) ou d'un matériau magnétique (114) couplé magnétiquement aux composants électriquement conducteurs (108) lorsque le projectile (112) se déplace le long de la longueur (110) de l'alésage (104); et dans lequel:

        le circuit (106) est configuré pour stocker l'énergie (116) générée à partir d'un courant électrique (118) induit dans les composants électriquement conducteurs (108) lorsque le projectile (112) se déplaçant le long de la longueur (110) de l'alésage (104) provoque une interaction magnétique (120) entre les composants électriquement conducteurs (108) et le au moins l'un parmi le matériau magnétique (114) ou le matériau conducteur (114), et
        l'interaction magnétique (120) est configurée pour provoquer le freinage du projectile (112),
        caractérisé en ce que le système de freinage régénératif (100) comprend en outre un connecteur (132) configuré pour fixer le canon (102) à une bouche (134) d'une arme à feu (130), dans lequel le projectile (112) comprend une balle (136) configurée pour être tirée dans le canon (102) à partir de la bouche (134), dans lequel: le canon (102) comprend un évent (138) positionné en avant des composants électriquement conducteurs (108), et
        dans lequel l'évent (138) est configuré pour évacuer un échappement (140) de l'arme à feu (130).

2. Système selon la revendication 1, dans lequel:

le projectile (112) est configuré pour générer un premier champ magnétique (122) configuré pour induire le courant électrique (118) dans les composants électriquement conducteurs (108) lorsque le projectile (112) se déplace le long de la longueur (110) de l'alésage (104), et
le courant électrique (118) est configuré pour générer un second champ magnétique (124) et les composants électriquement conducteurs (108) sont configurés de sorte que l'interaction magnétique (120) du second champ magnétique (124) avec le premier champ magnétique (122) provoque le freinage du projectile (112).

3. Système selon les revendications 1 ou 2, dans lequel l'interaction magnétique (120) est configurée pour induire un courant de Foucault dans le matériau conducteur (114) dans le projectile (112) se déplaçant le long de la longueur (110) de l'alésage (104).

4. Système selon la revendication 1, dans lequel les composants électriquement conducteurs (108) sont configurés de sorte que:

le projectile (112) sort de l'alésage (104) à une vitesse pouvant être arrêtée à la main, ou la vitesse est inférieure à 10 m/s, ou
le projectile (112) a une énergie cinétique (117) réduite d'au moins 90 % et au moins une partie de l'énergie cinétique (117) est convertie en énergie (116) comprenant l'énergie électrique (116).

5. Système selon l'une quelconque des revendications 1 à 4, dans lequel le matériau magnétique (114) comprend un aimant permanent (145).

6. Système selon l'une quelconque des revendications 1 à 5, dans lequel les composants électriquement conducteurs (108) comprennent des bobines (144).

7. Système selon l'une quelconque des revendications 1 à 6, dans lequel le circuit (106) comprend un ou plusieurs condensateurs (154) configurés pour stocker l'énergie (116) générée à partir du courant électrique (118).

8. Système selon la revendication 7, dans lequel les composants électriquement conducteurs (108) sont connectés en parallèle avec les condensateurs (154).

9. Système selon l'une quelconque des revendications 1 à 8, comprenant en outre:
une batterie (156) connectée au circuit (106), dans lequel la batterie (156) est configurée pour stocker l'énergie (116).

10. Système selon la revendication 9, dans lequel l'énergie (116) est capable d'alimenter au moins un dispositif (158) choisi parmi un téléphone portable, une radio, une télévision, un ordinateur, un système de positionnement global, un système de climatisation, ou un moteur de véhicule électrique.

11. Système selon les revendications 9 ou 10, dans lequel le circuit (106) comprend un circuit tampon pour: charger des condensateurs (154) en utilisant le courant électrique (118) et avec une première constante de temps conforme à une échelle de temps du projectile (112) se déplaçant le long de l'alésage (104), et décharger les condensateurs (154) dans la batterie (156) avec une seconde constante de temps plus longue que la première constante de temps et conforme à un temps de charge selon les spécifications du fabricant pour la batterie (156).

12. Véhicule (500) comprenant une arme électromagnétique (502) alimentée à l'aide du système selon l'une quelconque des revendications 1 à 11.

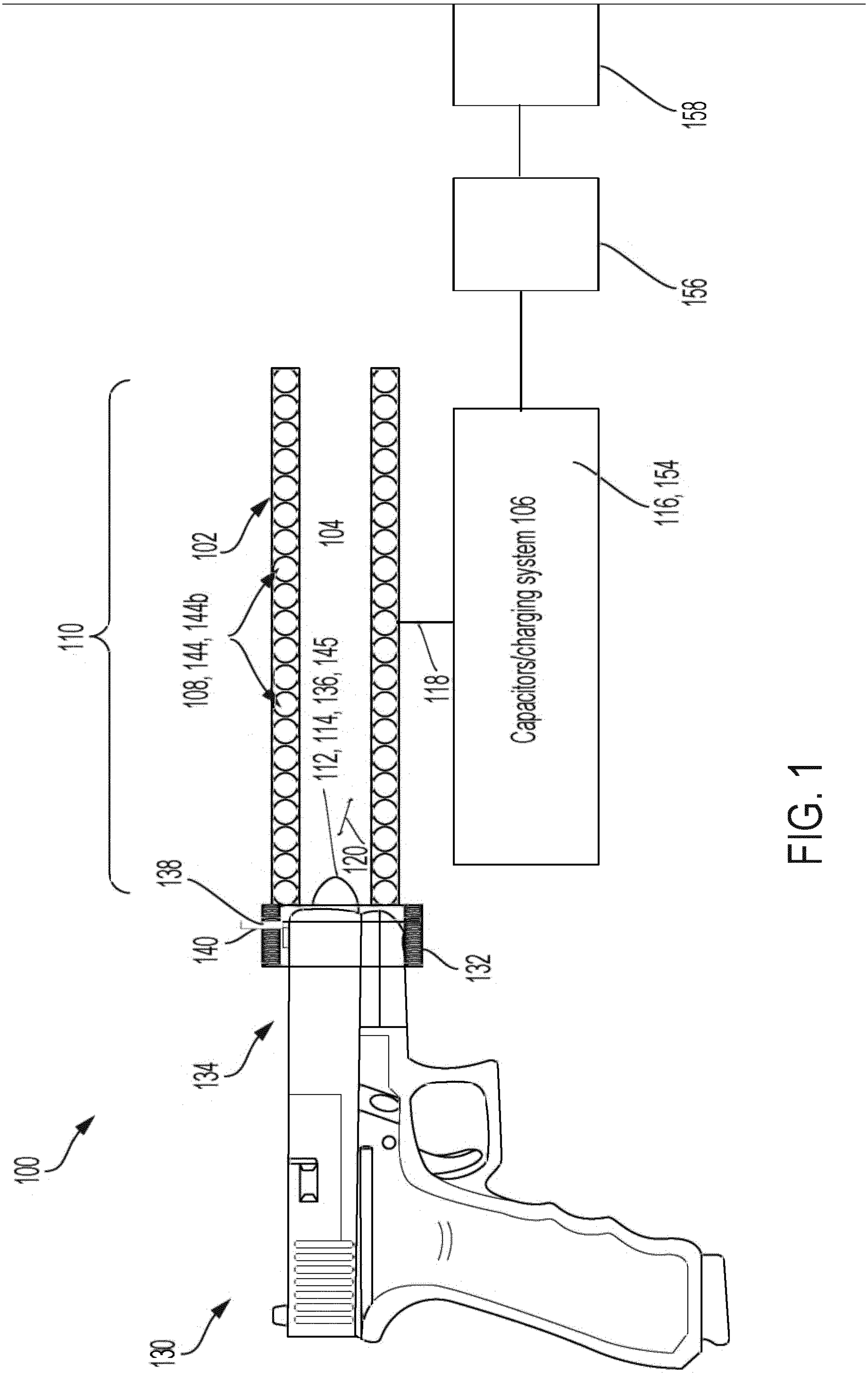
100
130
134
140
138
132
110
108, 144, 144b
102
104
112, 114, 136, 145
120
118
Capacitors/charging system 106
116, 154
156
158

FIG. 1

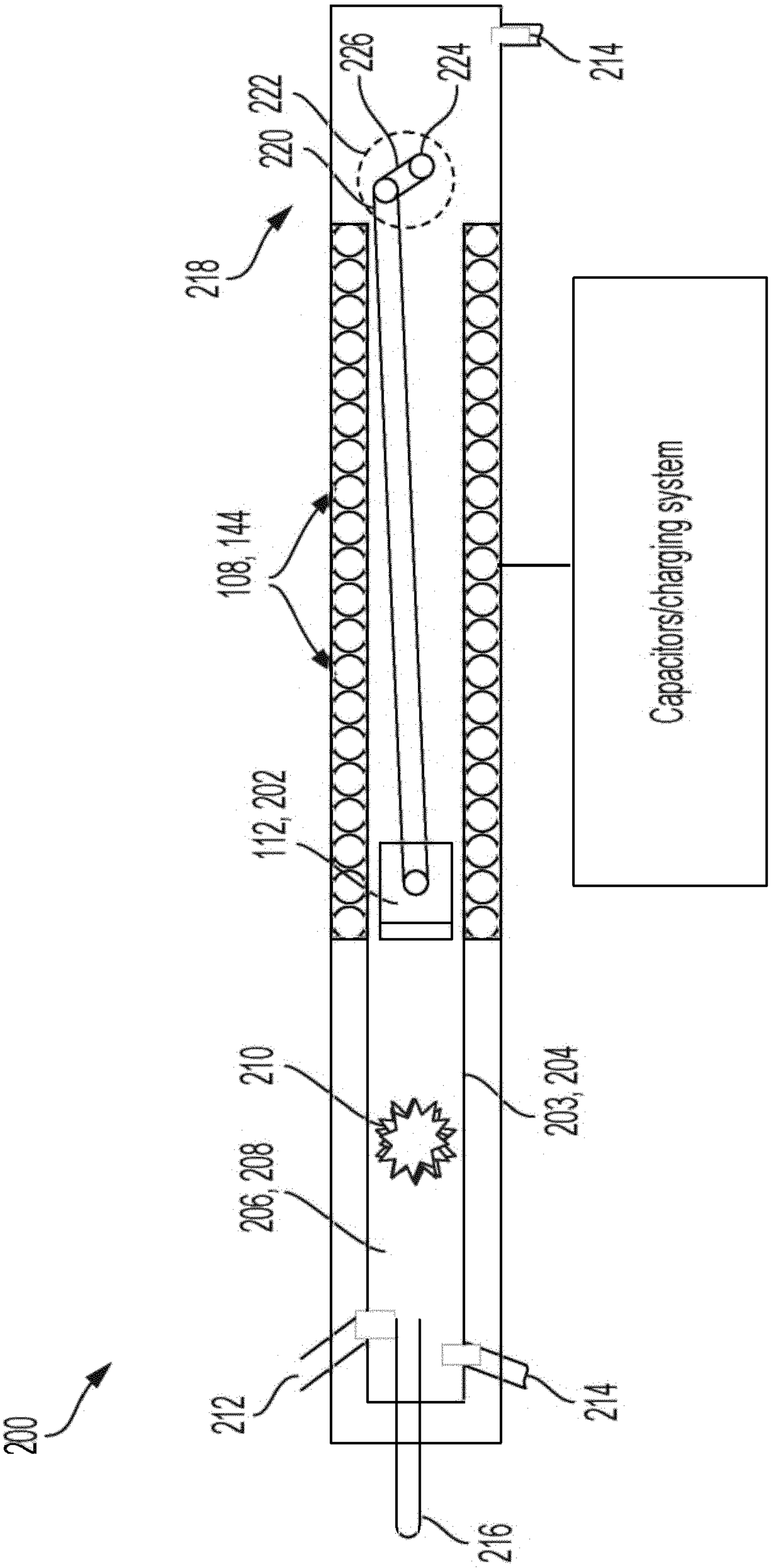
200
212
216
214
206, 208
210
203, 204
112, 202
108, 144
218
220
222
226
224
214
Capacitors/charging system

FIG. 2

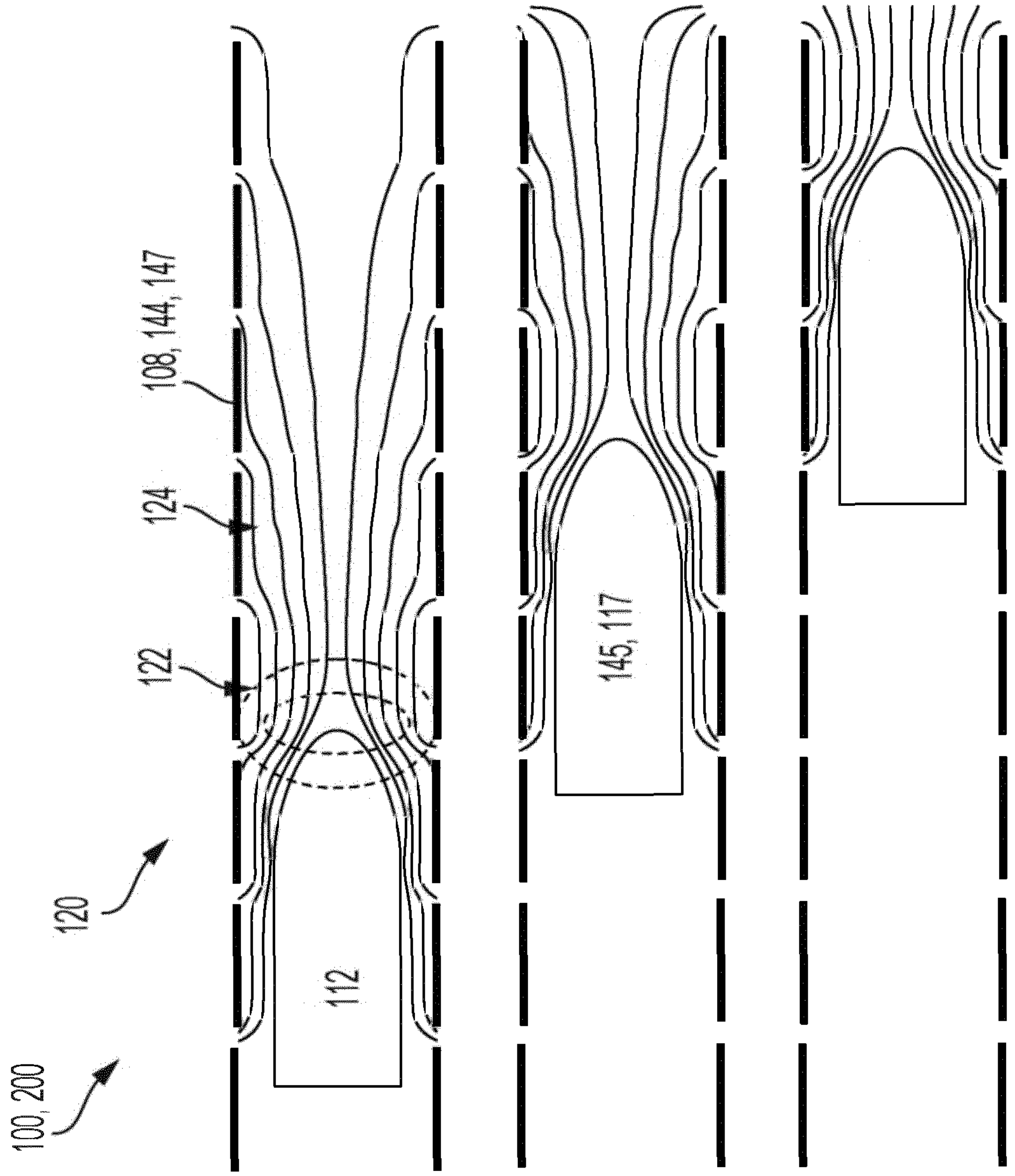

FIG. 3

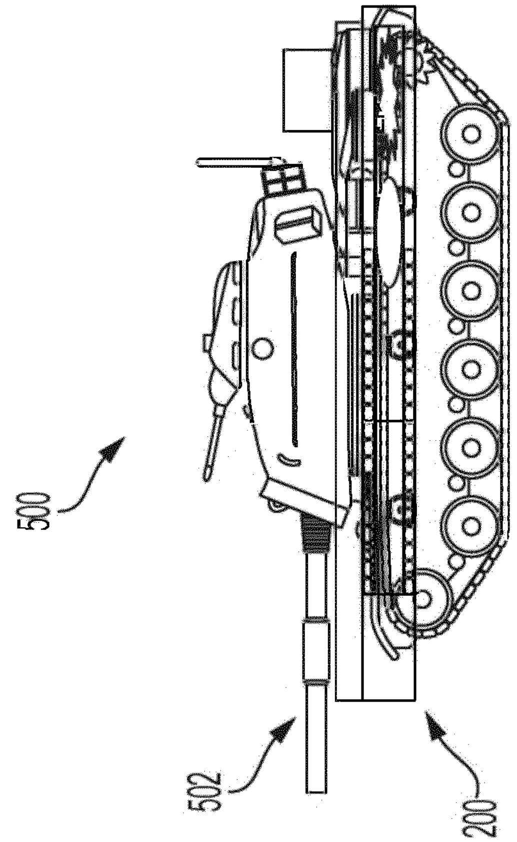

FIG. 5

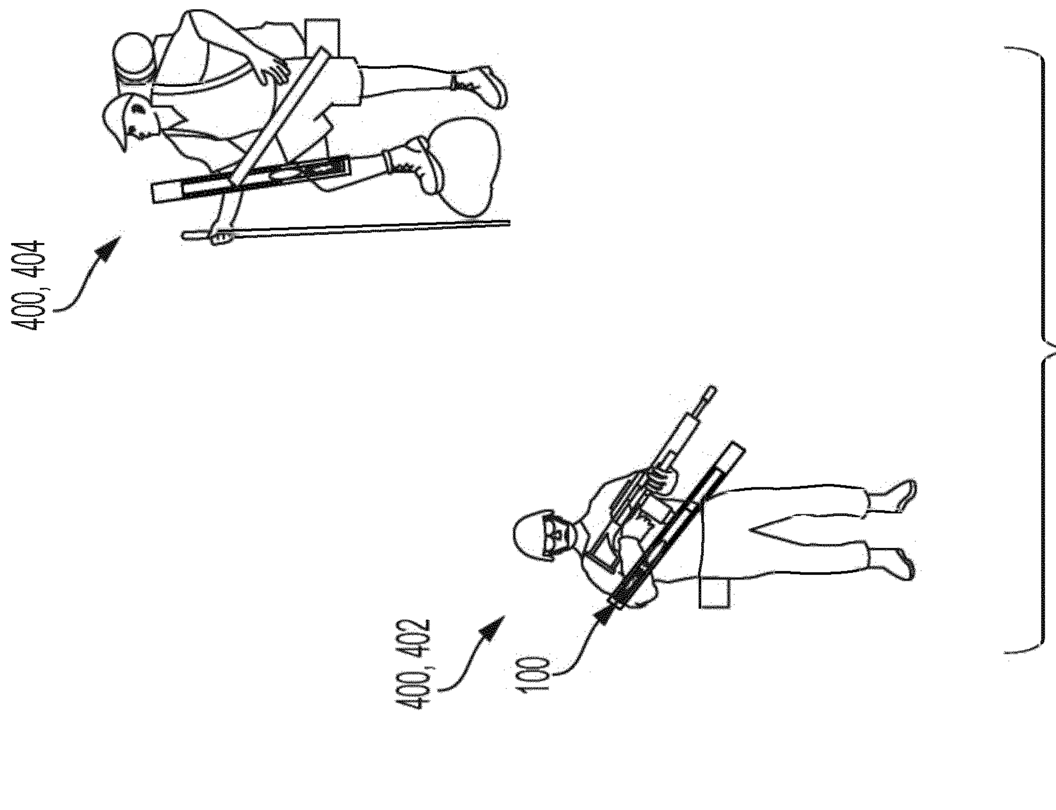

FIG. 4

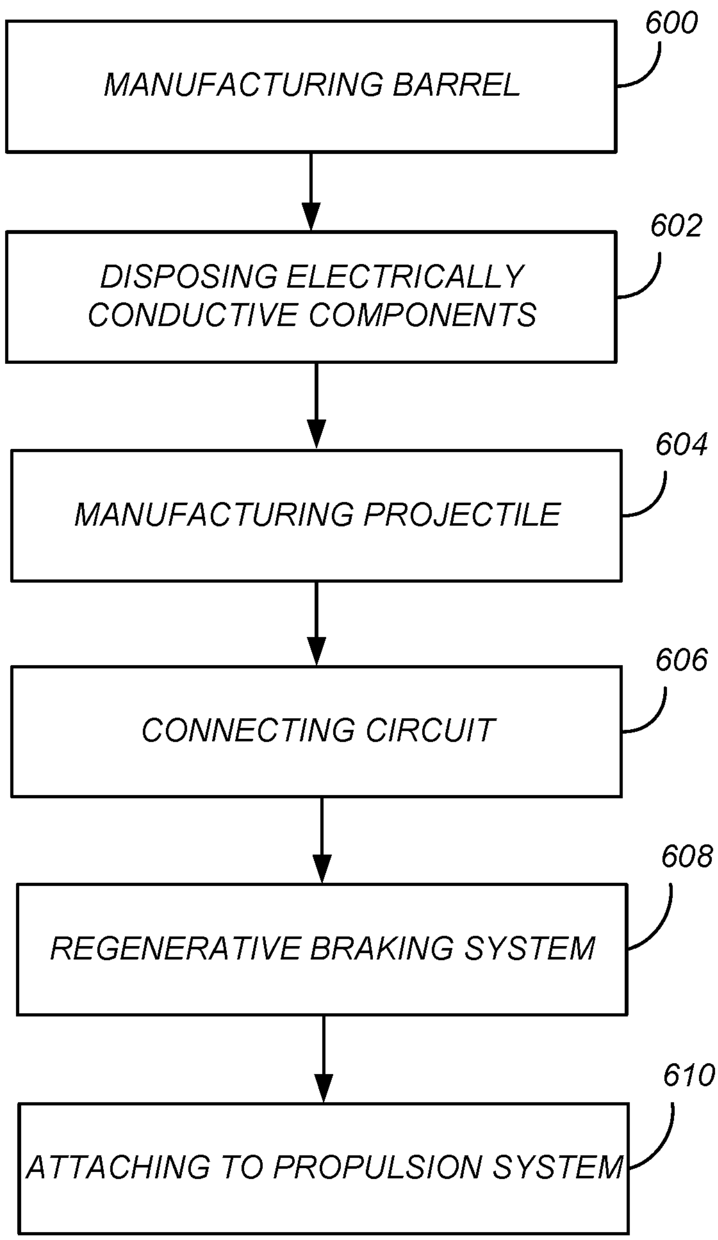
600
MANUFACTURING BARREL
602
DISPOSING ELECTRICALLY CONDUCTIVE COMPONENTS
604
MANUFACTURING PROJECTILE
606
CONNECTING CIRCUIT
608
REGENERATIVE BRAKING SYSTEM
610
ATTACHING TO PROPULSION SYSTEM

FIG. 6

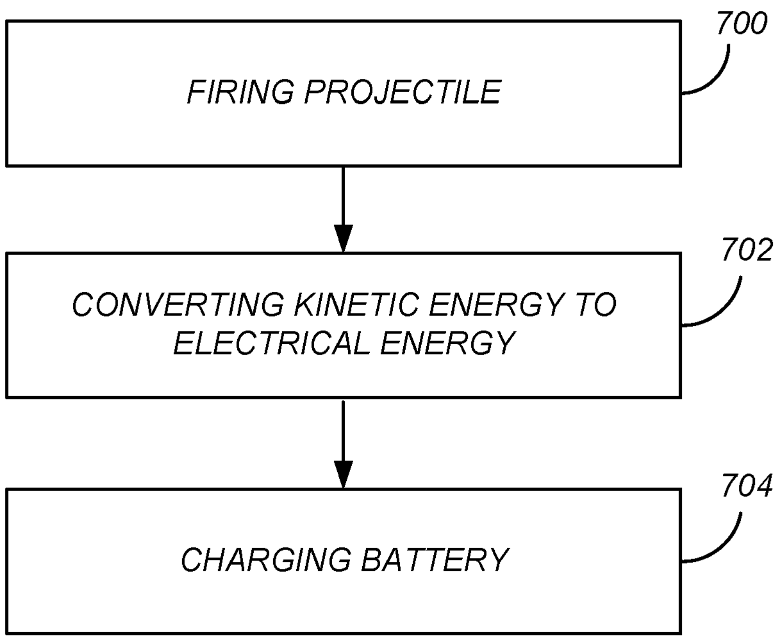
FIRING PROJECTILE
700
CONVERTING KINETIC ENERGY TO ELECTRICAL ENERGY
702
CHARGING BATTERY
704

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2009108589 A1 **[0003]**